

Fast Shutter Electro-mechanical Requirements

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1. Overview

This note documents the requirements used in the design of the aLIGO Fast Shutter Driver Circuit. This shutter blocks the high power optical pulse that is produced when the LIGO interferometer loses lock. At full operating power the LIGO arm cavities store approximately 50 Joules of energy. As this energy is released in a short time span (~20msec), the resulting optical pulse is large enough to cause damage to most materials. The shutter must actuate quickly and reliably to prevent damage to photodetectors and materials exposed to the laser beam.

2. Performance Requirements

Parameter	Value
Maximum time to block beam	≤ 1 mSec
Driver electronics peak output current	20 amperes peak
Driver electronics maximum output voltage	500 volts DC
Total time shutter must remain in blocked state	20 mSec to 40 mSec
Pulser duty factor	1 pulse per minute maximum
Fault detection	Must be able to detect disconnected interface cable from shutter controller or to shutter. Must be able to sense unpowered shutter controller.
Beam blocking modes	Fast blocking mode from rest condition plus a mode where the shutter can be held in the up position indefinitely

3. Interface Requirements

- a. **Outputs** (all are bit level outputs on a single female 25 pin D-sub connector)
 - i. High current pulse – Delivered via cable to in-vacuum fast shutter.
Unique output connector must be used to avoid inadvertent miswiring
 - ii. Ready to fire – (High when ready) Indication that energy storage capacitor is charged
 - iii. Pulse in progress – (Low during pulse) Indication that a pulse is being delivered to the shutter
 - iv. Blanking pulse – (Low during pulse) A separate indication that a trigger event has occurred. This may be used to blank a watchdog such that the shutter doesn't cause HAM6 watchdog trips when it fires.
 - v. Power supply fault – (Low on fault) Window comparators used to verify all power supply voltages are present

- vi. Fault condition – (Low on fault) Indicative of an unpowered shutter controller, an unplugged input cable from shutter controller, or an unplugged cable to the shutter.

b. Inputs

- i. Trigger input – BNC. Must receive a low-on-fault TTL level signal transition from shutter controller and respond in edge trigger only manner to prevent recurring pulses if the input trigger cable is disconnected.
- ii. High voltage power – Via a circularly polarized plastic connector (CPC). Up to 500 VDC supplied from remote power supply. Current requirements will be less than 100mA.
- iii. Low voltage power – Bipolar 18 volt supplies on standard LIGO 3 pin chassis power connector
- iv. Reverse pulse input – BNC connector that allows an external pulse to drive the shutter back into its hole in case it gets stuck in the vacuum system.